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A method and device for separation of a fluid, in particular oil, gas and water

The present invention concerns a method and device for separation of a fluid, in particular oil, gas and water, in connection with the extraction of such a fluid from formations under the surface of the earth or the sea bed, comprising a separator in the form of a tubular separator body, a gravitation tank or similar.

The applicant's own Norwegian patent application nos. 19994244, 20015048, 20016216, 20020619 and 20023919 describe prior art pipe separators for the separation of oil, water and/or gas downhole, on the sea bed or on the surface, on a platform or similar, in which various system solutions are used, comprising combinations and pipe separators and other separation equipment, that have contributed to a significant development of the separation technology, in particular for the separation of oil and water.

During tests, among other things in connection with the development of the above patented solutions, it emerged, however, as will be explained in further detail later, that it is possible to improve oil/water separation in certain situations by adding water to the oil/water fluid prior to separation. Moreover, it emerged that, by subjecting the fluid to shear forces prior to separation, faster phase inversion can be achieved, i.e. a faster transition from the initial fluid, consisting of a mixture of water dispersed in an oil phase, to separate layers of water and oil.

Against this background, the method in accordance with the present invention is characterised in that the fluid upstream of the separator is subjected to shear forces so that the drops in the supply flow are torn up into such small drops that the interface generally becomes new and "uncontaminated" by surfactants, as stated in the attached claim 1.

The device in accordance with the present invention is characterised in that a phase inversion device, in the form of a valve or similar, is arranged in the transport pipe upstream of the separator, as stated in the attached claim 5.

The dependent claims 2-4 and 6 define preferred embodyments of the present invention.

The present invention will be described in further detail in the following by means of examples and with reference to figures, where:

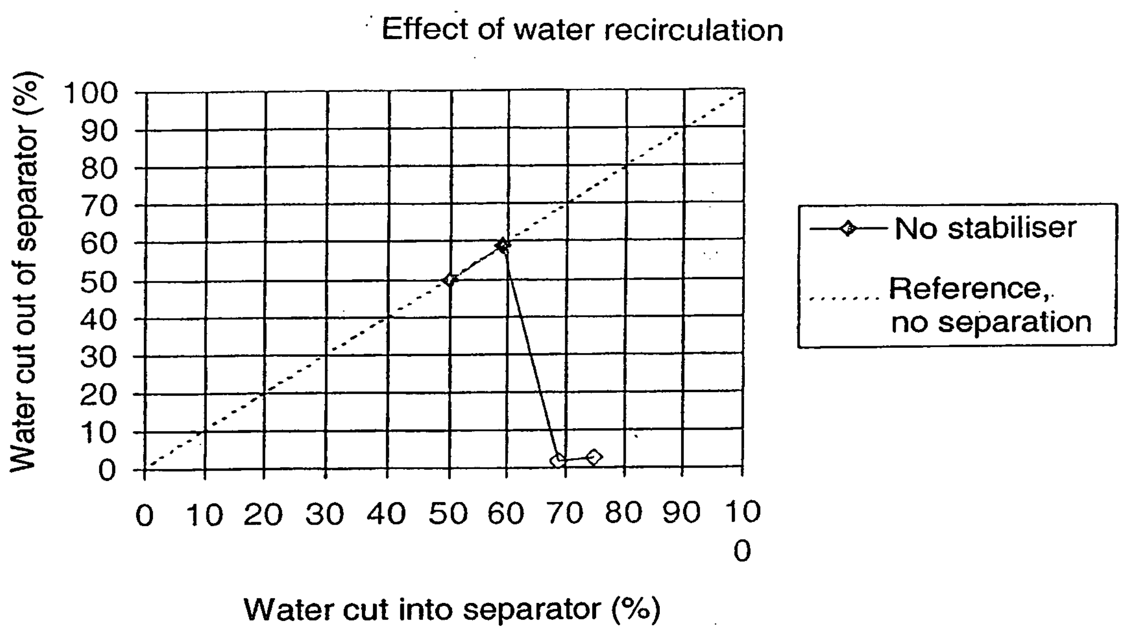
Fig. 1 shows a simple sketch of an equipment setup with pipes for oil and water that converge to form one fluid pipe in which oil and water are mixed. The fluid pipes are connected to a gravitation separator.

Fig. 2 shows the same as in Fig. 1 but a device has been inserted upstream of the separator that subjects the fluid to shear forces, for example a suitable valve or similar.

As stated above, Fig. 1 shows a simple sketch of a test setup in which water and oil are passed through pipes 2, 3, mixed in a mixing device 4 (that may be a throttle valve or a mixing pipe) and transported on as one fluid to a separator 1 in the form of a conventional gravitation separator designed as a cylindrical tank. Upstream of the separator 1 there was a supply pipe for the supply of water.
In principle, therefore, it is theoretically possible to improve oil/water separation of fluids by adding water and thus increasing the water cut to, for example, 70-75%, whereby the fluid must be water-continuous.

When this was done by adding water directly to the fluid as shown in the figure, the tests showed that the effect was unstable and unreliable, as no positive effect was generally achieved.

The diagram below shows the effect of water recirculation by comparing the water cut in the oil in % out of the separator with the water cut in the oil in % into the separator before admixture of water up to 75%.
The diagram shows that, when the original flow is oil-continuous (<= 60% WC (WC = water cut), no significant separation is achieved even if water is added to a total water cut of 75%. If the original flow is water-continuous (WC > 60%), the separation is fast and effective, as expected for water-continuous systems. At 75% original water cut, the fluid separates down to an outgoing water cut of around 2%. All of the points in the diagram are referred to 75% total water cut after adding "recirculated water".



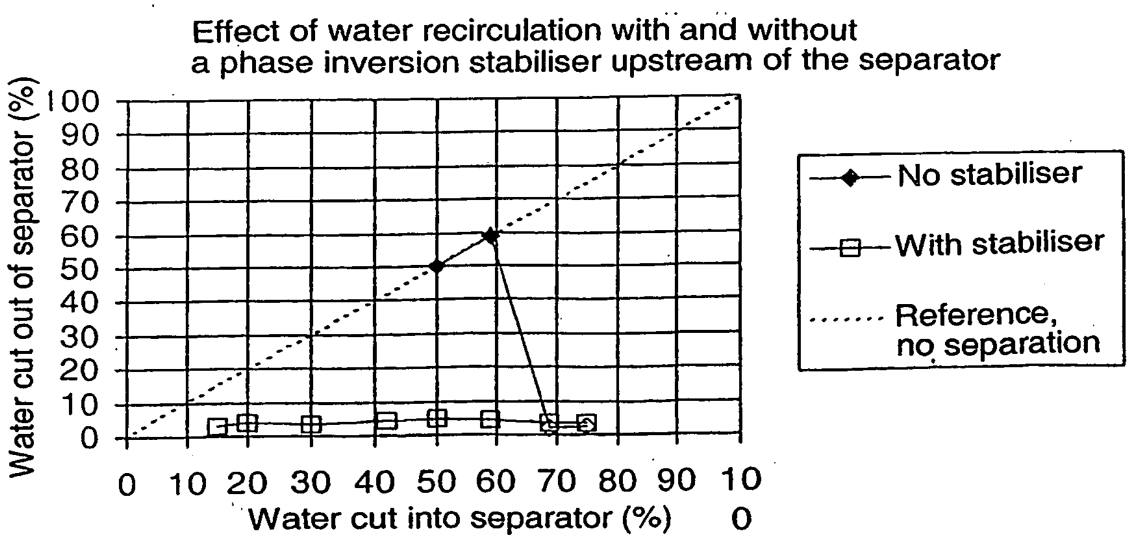
When a device (called a phase inversion stabiliser in the following) in the form of a valve or similar 6 that subjects the fluid to shear forces was inserted in the transport pipe 4 upstream of the separator 1 as shown in Fig. 2, the effect of recirculated water on oil/water separation proved to be stable and reliable. The diagram below shows the effect of water recirculation by comparing the water cut in the oil in % out of the separator with the water cut in the oil in % into the separator, with and without the liquid phase inversion stabiliser 6. As the diagram shows, a water cut out of the

separator lower than approximately 5% was achieved in the entire water cut range of the original fluid (15% to 75% WC).

The phase inversion stabiliser is a unit that subjects the fluid to shear forces. The most important criteria and functions of the unit are that:

1. The shear forces must be high enough to ensure that the drops in the supply flow are torn up to form drops that are so small that the interface generally becomes new and "uncontaminated" by the surfactants that are always present in crude oil systems. The new interface is therefore very unstable and the drops will begin a strong, intense coalescence process that leads to phase inversion.
2. When a large drop is torn up into smaller drops, the surface area between the oil and the water will increase. When torn up to just a third of the original diameter, the new drops will be unstable and the "phase inversion stabiliser" will have an effect.
3. The typical operation parameter will be to tear up the original drops to around less than 10% of the original drop diameter. This produces a stable phase inversion process.

The simplest practical design of the "phase inversion stabiliser" is as a sharp-edged valve (ball valve or similar). If the average drop size in the transport pipe upstream of the phase inversion stabiliser is around 1000 μm, a pressure drop over the valve of around 1 to 1.5 bar will be more than sufficient for stable phase inversion.



The present invention as it is defined in the claims is not limited to the examples shown in the figures and described above. Some crude oils may, for instance, be oil-continuous with 70-80% water cut during the transport of crude oil through pipes. Such flows can also be made water-continuous by means of the phase inversion stabiliser. The requirement is that the water cut in the oil is sufficiently high for a system to remain water-continuous when it has been phase-inverted. The addition of de-emulsifier can prevent the phase-inverted fluid from inverting back to being oil-continuous.